VIBRATING PILL PACKAGING DEVICE AND ASSOCIATED METHOD

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to pill packaging apparatuses and methods and, more particularly, to a vibrating pill packaging device and associated method for packaging pills, tablets, capsules, and the like.

Description of Related Art

Pharmaceutical products such as pills, tablets, capsules, and the like are often packaged in disposable packaging for distribution to the consumer. Such disposable packaging includes thermoformed and cold formed blister packages as well as pouches, sachets, or disposable bottles.

Conventional blister packages typically include a generally planar web portion having a plurality of receptacles formed therein. A thermoforming process, for example, can be used to form the receptacles in a thermoplastic web. Each receptacle in the web may receive one or more pills and the receptacles may be arranged in a grid pattern having multiple rows and columns. After pills have been placed in all of the receptacles, an aluminum or plastic foil layer is typically adhered to the planar web portion to seal the pills within the receptacles.

An important aspect of forming these packages relates to the placement of the pills in the receptacles prior to the foil layer being applied. This procedure is preferably performed by an automated machine capable of precisely and accurately placing the pills into the receptacles at a high speed. An exemplary form of such an apparatus has been commercially available under the name, "Aylward Feed System" from Aylward® Enterprises, Inc. of New Bern, N.C., also the assignee of the present invention. The

Aylward Feed System includes a feeder cassette and drop chute assembly having a plurality of chutes for guiding pills into the appropriate receptacles. An orienting tray is positioned above the feeder cassette for passing pills into the feeder cassette which, in turn, passes the pills into the drop chutes.

The orienting tray, the feeder cassette, and the drop chute assembly are mounted on a frame that extends over a conveyor having a series of empty pill blister packages placed thereon. The frame is generally movable in registration with the pill packages moving thereunder. The frame is fixed in the horizontal direction of the conveyor if the conveyor is an intermittent type. If the conveyor is a continuous type, the frame is moved on an undercarriage driven at the same speed as the conveyor. Therefore, with a continuous conveyor, the frame "gallops" back to register and moves with the next blister package after the preceding package has been filled.

Accordingly, as an empty pill package is moved under the drop chute, the drop chute is lowered and an escapement mechanism is activated in the feeder cassette to release a single pill that falls through the drop chute and into the corresponding receptacle in the package. More particularly, for example with blister packages, the drop chute is lowered and a pill is released to fall through the drop chute until it engages the bottom of the blister. The frame is then raised which, in turn, raises the drop chute and deposits the pill in the blister. This operation defines a gravity feed pill packaging system.

The drop chute assembly may include a plurality of individual chutes arranged in a block so as to define a grid. Each of the chutes extends in a generally vertical direction, but may include a portion at the lower end thereof which is angled so that a pill exiting the drop chute does so at an acute angle relative to the blister package.

In operation, where a pill is being packaged in a loose-fitting receptacle, this type of system will often place a pill into the blister receptacle by sliding a pill down the drop chute, wherein the lower end thereof is angled so that a pill exiting the drop chute is placed in the blister package at an acute angle relative thereto. Since the pill is deposited into the receptacle at an angle, it will sometimes "slide" into the receptacle until the leading edge of the pill engages a side wall thereof. The drop chute is then moved away from the blister receptacle to allow the trailing edge of the pill to clear the drop chute and drop into the receptacle under the force of gravity. Thus, the pill is introduced to the

receptacle, essentially diagonally, at an angle corresponding to the angle of the lower end of the drop chute. An apparatus and method of this type for packaging pills is disclosed in U.S. Patent No. 5,737,902 to Aylward, which is incorporated herein in its entirety by reference.

Although these types of feeders have achieved widespread commercial acceptance, problems may arise if the pills are being deposited into a package having receptacles that are closely toleranced or "tight fitting" with respect to the dimensions of the pills. Tight fitting receptacles are desirable in some instances, such as in blister packaging, wherein the tight tolerances minimize rattling of the pills within the receptacles. However, where a pill is to be inserted into a tightly toleranced receptacle using these types of systems, the pill may not be capable of simply being slid into the receptacle in a diagonal orientation.

For example, for a caplet generally having the shape of a transversely flattened capsule, the dimensions of the receiving receptacle in the blister package may be only slightly greater than the dimensions of the caplet. That is, the overall length and width of the receptacle may only be slightly greater than the overall length and width of the caplet, respectively. Accordingly, when the caplet is slid into the receptacle at an angle with the leading edge of the caplet dropping into the receptacle and engaging a side wall thereof before the trailing edge is released, the caplet may become oriented with its diagonal dimension approximately parallel or angled slightly upward relative to the planar web portion of the blister package. In this situation, the maximum dimension of a longitudinal cross-section of the caplet, here the diagonal dimension, may be slightly greater than the length of the accommodating receptacle and thus the trailing edge of the caplet will lie against a portion of the side wall of the receptacle, above the bottom wall thereof. The force of gravity may not be sufficient to cause the pill to drop fully into the receptacle, which leaves part of the trailing edge of the caplet extending above the planar web portion of the blister packet. This can also occur if the blister package material is wrinkled or otherwise distorted in the bottom or sides of the receptacle. In some instances, a caplet or pill may even "stand up" on its leading edge within a receptacle. As can be appreciated, these occurrences may have an adverse effect on the subsequent application of the foil layer if the trailing edge of the caplet or pill extends above the

plane of the blister package.

Thus, there exists a need for an improved packaging apparatus and method for placing pills and the like into pill receptacles such as blister packages in a preferred orientation, more particularly in the receptacle and below the planar web portion of the blister package, before application of a sealing foil layer. Such an apparatus and method should be able to quickly and accurately insert the pills, even the pills that are "standing up," into the receptacles to provide high packaging speed and quality. Such an apparatus and method should also be capable of efficiently and reliably inserting pills into receptacles dimensioned in close tolerance to the pills.

BRIEF SUMMARY OF THE INVENTION

The above and other needs are met by the present invention which, in one embodiment provides a packaging device for a pill packaging apparatus, wherein the packaging device cooperates with a plurality of pill receptacles, defined by a web and being conveyed by a conveyor under the packaging device in a packaging direction, to manipulate pills deposited in the receptacles into a laid-down position with respect to the receptacles. Such a packaging device comprises a first wiper device, extending across the web and non-perpendicularly to the packaging direction, configured to engage pills protruding from the receptacles. A second wiper device, downstream of the first wiper device and extending across the web substantially perpendicularly to the packaging direction, is configured to engage any pills still protruding from the receptacles following engagement with the first wiper device. The first and second wiper devices are configured to oscillate substantially transversely to the packaging direction so as to vibrate laterally with respect to the web. The lateral vibration of the first and second wiper devices, as the wiper devices engage any protruding pills, thereby causes the protruding pills to be manipulated into the laid-down position in the corresponding receptacles.

Another advantageous aspect of the present invention comprises a packaging device for a pill packaging apparatus, wherein the packaging device cooperates with a plurality of pill receptacles, defined by a web and being conveyed by a conveyor under the packaging device in a packaging direction, to manipulate pills deposited in the

receptacles into a laid-down position with respect to the receptacles. Such a packaging device includes a first wiper device, extending across the web and non-perpendicularly to the packaging direction, configured to engage pills protruding from the receptacles. A second wiper device, disposed downstream of the first wiper device and extending across the web substantially perpendicularly to the packaging direction, is configured to engage any pills still protruding from the receptacles following engagement with the first wiper device. A plate extends across the web and supports the first and second wiper devices, wherein the plate is configured to oscillate substantially transversely to the packaging direction so as to cause the first and second wiper devices to vibrate laterally with respect to the web. The lateral vibration of the first and second wiper devices, as the wiper devices engage any protruding pills, thereby causes the protruding pills to be manipulated into the laid-down position in the corresponding receptacles.

Still another advantageous aspect of the present invention comprises a pill packaging apparatus for packaging pills in a plurality of pill receptacles defined by a web. Such a pill packaging apparatus includes a conveyor for conveying the web in a packaging direction and a feeder mechanism configured to deposit pills into the receptacles. A packaging device is disposed downstream of the feeder mechanism with respect to the conveyor and further includes a first wiper device extending across the web and non-perpendicularly to the packaging direction, wherein the first wiper device is configured to engage pills protruding from the receptacles. A second wiper device is disposed downstream of the first wiper device and extends across the web substantially perpendicularly to the packaging direction. The second wiper device is configured to engage any pills still protruding from the receptacles following engagement with the first wiper device. The first and second wiper devices are further configured to oscillate substantially transversely to the packaging direction so as to vibrate laterally with respect to the web. The lateral vibration of the first and second wiper devices, as the wiper devices engage any protruding pills, thereby causes the protruding pills to be manipulated into the laid-down position in the corresponding receptacles.

Yet another advantageous aspect of the present invention comprises a method for packaging pills in individual receptacles in a web being conveyed in a packaging direction. First, pills are deposited into the receptacles in the web. A first wiper device,

disposed non-perpendicularly with respect to the packaging direction, then engages any pills protruding from the receptacles. A second wiper device, disposed substantially perpendicularly with respect to the packaging direction, is then engaged with any pills still protruding from the receptacles following engagement with the first wiper device. The first and second wiper devices are concurrently oscillated substantially transversely to the packaging direction such that the first and second wiper devices vibrate laterally with respect to the web. The lateral vibration of the first and second wiper devices, as the wiper devices engage any protruding pills, thereby causes the protruding pills to be manipulated into a laid-down position in the corresponding receptacles.

Thus, embodiments of the present invention provide significant advantages as disclosed, described, and further detailed herein.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING(S)

Having thus described the invention in general terms, reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

FIGS. 1 and 2 are schematic perspective views of a pill packaging apparatus including a packaging device according to one embodiment of the present invention;

FIG. 3 is a schematic plan view of a packaging device according to one embodiment of the present invention;

FIG. 4 is a schematic cross-sectional view of a wiper device component of a packaging device according to one embodiment of the present invention;

FIG. 5 is a schematic bottom view of a packaging device according to one embodiment of the present invention; and

FIG. 6 is a schematic front view of a packaging device according to one embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all embodiments of the invention are shown. Indeed, this invention may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these

embodiments are provided so that this disclosure will satisfy applicable legal requirements. Like numbers refer to like elements throughout.

FIGS. 1 and **2** disclose one embodiment of a pill packaging apparatus, indicated generally by the numeral **100**, for packaging pills in a series of pill receptacles. The pill packaging apparatus **100** generally comprises a conveyor **120**, a feeder mechanism **140** extending over the conveyor **120**, and a packaging device **160** disposed downstream of the feeder mechanism **140** with respect to the conveyor **120**. Typically, the conveyor **120** conveys a series of blister packages **180** generally horizontally along the travel path of the conveyor **120**. The feeder mechanism **140** deposits pills **200** into the blister packages **180** in a predetermined manner as the blister packages **180** are transported by the conveyor **120**. A more detailed description of an apparatus having a feeder mechanism for supplying pills into a series of pill receptacles being transported on a conveyor thereunder may be found, for example, in U.S. Patent No. 5,737,902 to Aylward.

As used herein, the term "pill" is intended to include all types of small discrete products of the type which may be used in the pharmaceutical industry, including pills, tablets, capsules, caplets, and soft gel caplets or the like. Similarly, the packages are illustrated as blister packages having blisters that may be formed by thermoforming if the packages are made from a thermoplastic material. It will be understood, however, that the present invention is not limited to placing pills into blister packages, but indeed may be used for placing pills into a variety of different pill receptacles. In addition, it will be understood that the present invention is not limited to placing pills into disposable pill packages, but may also be used for placing pills into reusable holders so that the pills may then be transferred to other operations, such as a pill placement device for moving the pills from the holder into a disposable package. Thus, the examples disclosed herein with respect to embodiments of the present invention are not intended to be limiting or restricting, and one skilled in the art will appreciate that the apparatuses and methods disclosed herein may also be applicable to many different configurations of pill packaging apparatuses and associated methods.

The blister packages **180** typically comprise, for instance, a generally planar web portion **182** and a plurality of receptacles **184** extending below the web portion **182**. As the blister packages **180** pass underneath the feeder mechanism **140** in a packaging

direction (shown as arrow **110**), at least one pill **200** is typically released into each receptacle **184**. Once pills **200** have been deposited into each receptacle **184**, the receptacles **184** are typically sealed with a foil or other sealing layer (not shown) applied to the planar web portion **182**.

In some instances, for example, where the receptacles **184** are dimensioned in close tolerance to the pills **200**, the pills **200** may not lie flat within the receptacles **184** after being deposited therein by the feeder mechanism **140**, as shown in **FIGS. 1, 2, and 4**. Accordingly, such pills **200** are referred to herein as "protruding" from the receptacles **184**. The protruding pills **200** may, for example, lie against the opening of the receptacle **184** at the planar web portion **182** or, where the pills **200** have a flat band **202** extending around the perimeter thereof, the pills **200** may even "stand up" on the band **202** within the receptacle **184**. In such instances, the sealing layer may be difficult to apply or not capable of being applied to the planar web portion **182** to seal pills **200** within the receptacles **184**. Thus, after each blister package **180** has passed under the feed mechanism **140** and has received the appropriate amount of pills **200** therein, the blister packages **180** are serially conveyed downstream in the packaging direction **110** by the conveyor **120** to pass under the packaging device **160** for manipulating any protruding pills **200** into the desired flat orientation or "laid-down position" within the individual receptacles **184**.

As shown in **FIGS. 2-6**, a packaging device **160** according to embodiments of the present invention includes at least one first wiper device **300** configured to be capable of engaging at least some pills **200** protruding from the receptacles **184**. Preferably, the first wiper device **300** extends across the blister package **180** and is disposed non-perpendicularly with respect to the packaging direction **110**. In one advantageous embodiment, the first wiper device **300** is disposed at an angle of about 45° with respect to the packaging direction **110**, though one skilled in the art will appreciate that the angle may vary. Since the embodiment shown in **FIGS. 1-6** includes three series of blister packages **180** being conveyed in the packaging direction **110** by the conveyor **120**, three such first wiper devices **300** are illustrated, wherein each first wiper device **300** is configured to interact with a respective one of the series of blister packages **180**. Each

first wiper device **300** is configured to extend across a series of blister packages **180** so as to be capable of engaging pills **200** protruding from the receptacles **184**.

The packaging device **160** further includes at least one second wiper device **350** disposed downstream of the first wiper device(s) **300** and substantially perpendicularly with respect to the packaging direction **110**. In the embodiment shown in **FIGS. 1-6**, a single second wiper device **350** extends across the three series of blister packages **180**, though one skilled in the art will appreciate that the second wiper device **350** may vary in number if desirable. The second wiper device **350** is thus configured to extend across the series of blister packages **180** engaged by the corresponding first wiper device **300** so as to be capable of engaging any pills **200** still protruding from the receptacles **184** following engagement with the first wiper device **300**.

In one advantageous embodiment of the present invention, the first and second wiper devices **300,350** are further configured to vibrate when engaging protruding pills **200** so as to manipulate the protruding pills **200** into the laid-down position within the corresponding receptacle **184** in the blister package **180**. More particularly, in some embodiments, the first and second wiper devices **300,350** are configured to oscillate transversely with respect to the packaging direction **110** and at a sufficient frequency such that the first and second wiper devices **300,350** essentially laterally vibrate with respect to the series of blister packages **180** being conveyed by the conveyor **120**. In this manner, the laterally vibration of the first and second wiper devices **300,350** and the contact between the first and second wiper devices **300,350** and the pills **200** protruding from the receptacles **184** combine to manipulate the protruding pills **200** into the laid-down position within the corresponding receptacles **184**.

As shown, the first and second wiper devices **300,350**, in some instances, are mounted to a plate **400**, wherein the plate **400** is configured to support the first and second wiper devices **300,350** above the blister packages **180** being conveyed by the conveyor **120** so as to allow the first and second wiper device **300,350** to engage any pills **200** protruding from the receptacles **184**. One skilled in the art will further appreciate that the pill packaging apparatus **100**, as described, may be configured as a continuous motion pill packaging apparatus, wherein the conveyor **120** continuously conveys the blister packages **180**, and an indexing pill packaging apparatus, wherein the blister

packages **180** are moved in successive discrete indices such that one blister package **180** at a time is acted upon by the feeder mechanism **140** and packaging device **160**. Where the pill packaging apparatus **100** is a continuous motion pill packaging apparatus, the packaging device **160** as described herein may be configured to be stationary with respect to the conveyor **120** so as to act on the protruding pills **200** as the blister packages **180** are continuously conveyed under the plate **400**. In instance where the pill packaging apparatus **100** is an indexing pill packaging apparatus, the packaging device **160** may be stationary and configured to act one the protruding pills **200** as the blister packages **180** are moved to the next successive discrete index. In other instances, the packaging device **160** may be configured to move with respect to the blister packages **180** so as to act on the protruding pills **200** as the blister packages **180** are between indices and stationary on the conveyor **120**. After acting on the protruding pills **200** in a particular blister package **180**, the packaging device **160** is then returned to register to await the next blister package **180** at the next index of the conveyor **120**.

Some embodiments of the packaging device **160** may also include a vibration-inducing device **500** engaged with the plate **400** for facilitating the transverse oscillation of the first and second wiper devices **300,350**. The vibration-inducing device **500** may particularly comprise, for example, a pneumatic vibrator **525** for producing the necessary vibration, controlled by a frequency controller **550** for controlling the frequency of the vibration, though one skilled in the art will appreciate that the transverse oscillation of the first and second wiper devices **300,350** may be accomplished in many different manners such as, for example, by using a piezoelectric device. The pneumatic vibrator **525**, in one instance, is mounted to the plate **400** substantially transversely to the packaging direction **110** such that, upon actuation, the lateral vibration is transmitted to the first and second wiper devices **300,350** via the plate **400**. However, one skilled in the art will appreciate that, in some cases, the packaging device **160** may be configured so as to allow the vibration-inducing device **500** to vibrate the first wiper device **300** at a different frequency from the second wiper device **350**.

In some cases, it may be advantageous to isolate the vibration produced by the vibration-inducing device **500** from the conveyor **120**. For example, such vibration isolation may be advantageous in reducing or eliminating blurred vision data in vision

systems used along the pill packaging apparatus **100**. Accordingly, the plate **400** may be mounted to the conveyor **120** via mounting members **600**, wherein the mounting members **600** are configured in such case to dampen the vibrations or otherwise substantially isolate the conveyor **120** from the vibrations. For example, the mounting members **600** may comprise a solid resilient member or a hydraulic dampening device, as will be appreciated by one skilled in the art. In the alternative, the plate **400** may be supported by a separate frame (not shown) extending over the conveyor **120**, with the frame including vibration-dampening provisions.

As also shown in **FIGS. 2-6**, the first and second wiper devices **300,350**, in some embodiments, are configured to be mounted to an upper surface **410** of the plate **400** and extend through respective slots **650** defined by the plate **400** so as to be capable of engaging the protruding pills **200**. One advantage of such a configuration is that the first and second wiper devices **300,350** may be accessed from above the plate **400** without having to remove the plate **400** from the mounting position above the conveyor **120**. Further, the first and second wiper devices **300,350** should be mounted with respect to the plate **400** so as to be capable of manipulating the protruding pills **200** into the laid-down position within the receptacles **184**, but without dragging the pills **200** out of the receptacles **184** and/or without causing damage to the pills **200** or corresponding receptacles **184** by trapping the protruding pills **200** against the planar web portion **182**/receptacle **184** interface. Accordingly, the first and second wiper devices **300,350** are mounted to the plate **400** in spaced apart relation with respect to the planar web portion **182** so as to be capable of engaging the protruding pills **200**, but without causing the aforementioned undesirable effects, as will be appreciated by one skilled in the art

In some instances, the receptacles **184** are arranged in columns with respect to the packaging direction **110** in the blister package **180**. As such, it would also be undesirable for the lateral vibration of the first and second wiper devices **300,350** to move a protruding pill **200** to a different column in the blister package **180**. Accordingly, in such instances, the lower surface **420** of the plate **400** defines a plurality of channels **430** extending in the packaging direction **110** and corresponding to the columns of receptacles **184** in the blister package **180**. Adjacent channels **430** are separated by a tine **440** having a width roughly corresponding to the separation distance between adjacent columns in the

blister package **180**, wherein each tine **440** is configured to extend into proximity with the planar web portion **182** of the blister package **180** so as to prevent movement of pills **200** between columns. Each channel **430** extends toward the upper surface **410** of the plate **400** and ends in an upper bound **435**. As such, in order for the first and second wiper devices **300,350** to engage the protruding pills, each slot **650** extends through the upper bounds **435** of the channels **430** and partially through the tines **440** separating the channels **430**, as shown in **FIG. 4**. One skilled in art will also appreciate that the separate channels **430** and the limited transverse translation of the first and second wiper devices **300,350**, while the first and second wiper devices **300,350** are laterally vibrated, may also reduce or eliminate cross-contamination in instances where the pills **200** loaded into one column of the blister package **180** are different from the pills **200** loaded into an adjacent column.

One skilled in art will also appreciate that there may be instances in which the pills **200** loaded into one row of the blister package **180**, transverse to the packaging direction **110**, are different from the pills **200** loaded into the next adjacent row. For example, two different types of pills **200** may be loaded in alternating rows in the blister package **180**. In such instances, two packaging devices **160** as described herein may be provided, or a single packaging device **160** with two sets of first and second wiper devices **300,350**, whereby each packaging device **160** or each set of first and second wiper devices **300,350** is configured to act upon every other row of the blister package **180** and thus interact with only one type of pill **200** during the packaging process. Accordingly, a pill packaging apparatus **100** configured in such a manner may also reduce or eliminate cross-contamination between the adjacent rows of the blister package **180**.

In some embodiments of the present invention, the first and second wiper devices **300,350** may comprise, for example, a cloth material or other material approved by the appropriate regulatory agency as being suitable for use in pharmaceutical packaging operations. In the alternative, for example, the first and second wiper devices **300,350** may comprise an appropriately configured rubber or polymer material. The material comprising the first and second wiper devices **300,350** thus functions as a wiper and

should be capable of manipulating the protruding pills **200** into the receptacles **184** without causing abrasion of or otherwise damaging the pills **200**.

In cases where the first and second wiper devices **300,350** are comprised of a cloth material, the packaging device **160** may include one or more support members **700** disposed adjacent to and extending along the length of each slot **650**. The support members **700** are configured such that, when a straight edge **725** of a strip **750** of the cloth material is inserted into a slot **650**, the remainder of the strip **750** may be folded over the support member(s) **700** and secured thereto by one or more clip members **800**. Preferably, the strip **750** extends substantially along the length of the corresponding slot **650**, with the support member(s) **700** and corresponding clip member(s) **800** cooperating to secure the strip **750** to the plate **400** and contiguously support the strip **750** along the length of the respective slot **650** so as to facilitate the lateral vibration of the strip **750**. In this manner, the strip **750** is also readily removable through removal of the clip member(s) **800** securing the strip **750** to the support member(s) **700**. As such, the strip **750** may be easily replaced when worn out or to prevent cross-contamination in a subsequent pill packaging process. One skilled in the art will appreciate, however, that the first and second wiper devices **300,350** may be configured in other manners. For example, the strip **750** may be permanently attached to the support member(s) **700** to form a wiper assembly, wherein the support member(s) **700** may be configured to be capable of removably engaging the plate **400** such that the entire wiper assembly is replaced when necessary.

Many modifications and other embodiments of the invention set forth herein will come to mind to one skilled in the art to which this invention pertains having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. For example, the procedure described herein supports a method of packaging pills **200** in receptacles **184** in a blister package **180**. More particularly, after depositing the pills **200** into the receptacles **184**, the first wiper device **300** disposed non-perpendicularly with respect to the packaging direction **110** is brought into engagement with any pills **200** protruding from the receptacles **184**, whereafter the second wiper device **350,** disposed substantially perpendicularly with respect to the packaging direction **110,** is then brought into engagement with any pills **200** still protruding from the receptacles **184** following

engagement with the first wiper device **300**. The first and second wiper devices **300,350** are oscillated substantially transversely to the packaging direction **110** so as to vibrate laterally with respect to the blister package **180**, concurrently with the respective engagements of the first and second wiper devices **300,350** with the protruding pills **200**, and thus cause any protruding pills **200** to be manipulated into a laid-down position in the corresponding receptacles **184**. Therefore, it is to be understood that the invention is not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.